

VEGETATION AND FLORA OF PINE BUTTE FEN, TETON COUNTY, MONTANA

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ABSTRACT.—The Pine Butte Fen, situated east of the Rocky Mountains in north central Montana, is a boreal, patterned peatland occurring in a relatively dry climatic region. It is one of the southernmost mires of its kind in North America. The vegetation communities present in the fen are described, and possible causes of vegetation patterning are discussed. The Pine Butte Fen is a minerotrophic fen with 93 species of vascular plants represented in an area of approximately 450 ha. Floristic similarities between the Pine Butte Fen and 11 other peatlands in North America reported in the literature are low. Similarity of this fen to other peatlands tends to decrease with increasing distance between the sites and decreasing pH of surface water at other sites. Possible causes for these trends and the floristic uniqueness of the Pine Butte Fen are discussed.

Peatlands (mires) are a common feature in the boreal zones of the earth. Bogs and fens are abundant in northern and central Alberta and Saskatchewan and often cover hundreds of square kilometers in the Hudson Bay Lowlands of Ontario and the Glacial Lake Agassiz region of northern Minnesota (Sjors 1959, Heinselman 1963, Glaser 1983). West of the Continental Divide in Montana, small mires are common in forested areas at low to midelevations where climate is relatively moist and there has been a history of glaciation. East of the Divide mires are generally small and restricted to montane areas. There are no previously published vegetation studies of Montana peatlands.

This study reports the vegetation and flora of the Pine Butte Fen, a large patterned fen in north central Montana situated at the interface of the Northern Great Plains and the east front of the main range of the Rocky Mountains. The Pine Butte Fen is part of the Pine Butte Preserve, a sanctuary established by The Nature Conservancy to protect the last area in the continental United States where large numbers of grizzly bears, *Ursus horribilis*, still migrate onto the plains to feed. Inaccessible and inhospitable terrain has allowed the large wetland complex surrounding Pine Butte to remain the last low-elevation stronghold of the grizzly in the lower 48 states. This report is part of a larger study providing a classification system for and descriptions of the wetland and riparian vegetational communities found in this unique area (Lesica 1982).

Peatlands have been studied extensively in Scandania (Sjors 1950, 1980), England (Pearsall and Lind 1941, Pearsall 1955), Canada (Moss 1953, Sjors 1959, Vitt et al. 1975, Slack et al. 1980), and the Great Lakes region of the United States (Heinselman 1963, 1965, 1970, Schwintzer 1978, Schwintzer and Tomberlin 1982, Glaser et al. 1981, Glaser 1983). Good general reviews of the literature concerning peatland vegetation and ecology are provided by Gorham (1957) and Moore and Bellamy (1974). There is a large body of literature dealing with relationships between mire vegetation and water and soil chemistry (Sjors 1950, Jeglum 1971, Waughman 1980, Schwintzer and Tomberlin 1982, Glaser et al. 1981, and Karlin and Bliss 1984). The surface patterning typical of boreal bogs and fens has been discussed by Sjors (1961), Heinselman (1963, 1970), and Glaser (1983).

STUDY AREA

The Pine Butte Fen is on the west side of Pine Butte, approximately 45 km west of Choteau in Teton Co., Montana (47°50'N, 32°30'W, Fig. 1). The fen covers approximately 450 ha on a gentle southeast-trending slope. The Pine Butte area is underlain by glacial outwash derived from calcareous shales and limestones from the main range of the Rocky Mountains that rise abruptly 9 km to the west. Water flowing south from the Teton River through this permeable till rises

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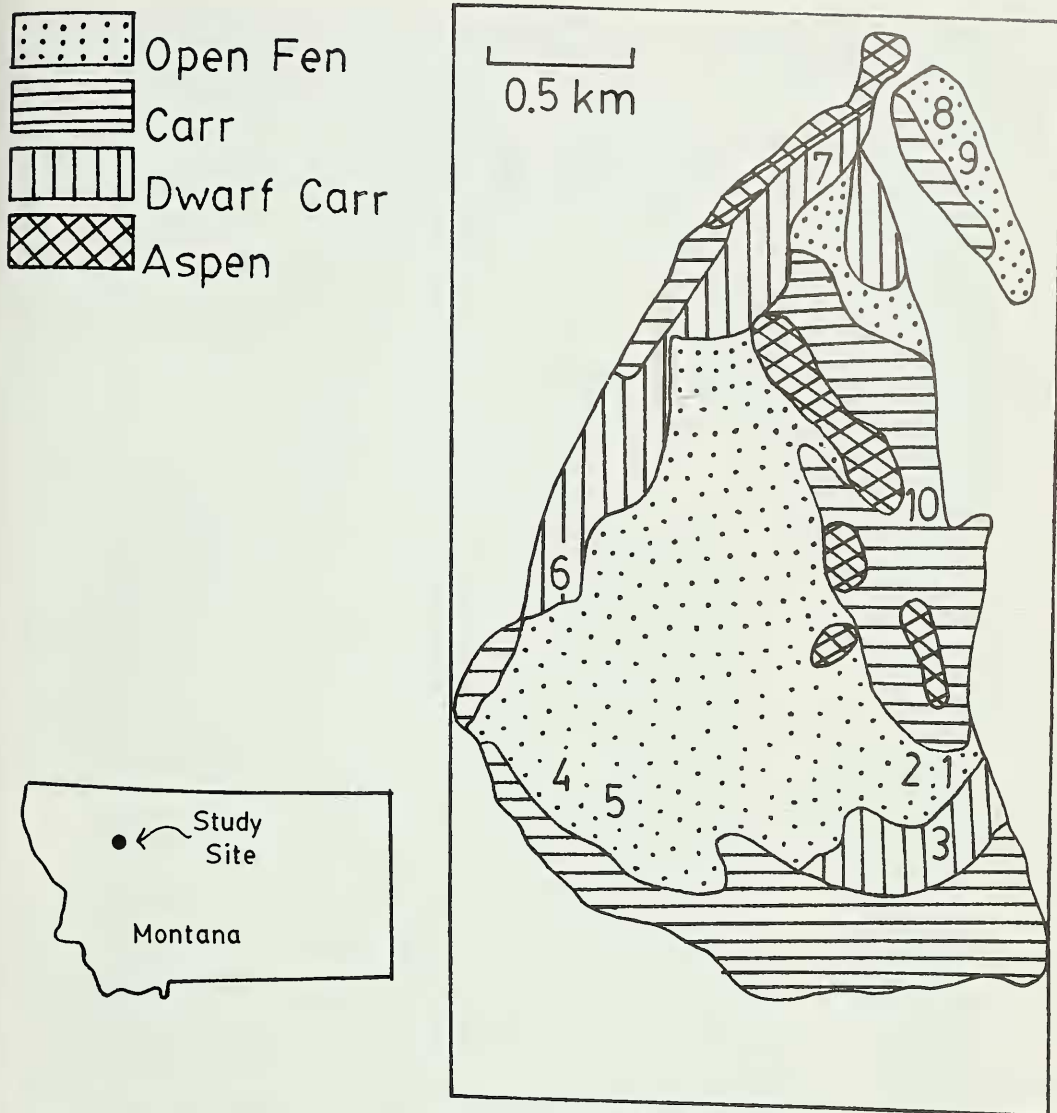


Fig. 1. Vegetation community types in the Pine Butte Fen. Numbers refer to sample stands listed in Table 1.

to the surface in the Pine Butte Fen, providing a nearly constant supply of cold, nutrient-enriched water (Nimick et al. 1983). Fen vegetation occurs on organic soils (peat) 0.5–3.0 m thick. Mean annual precipitation is estimated to be 430 mm and mean annual temperature is 6.0 C (USDA 1980). The precipitation/evaporation ratio along the east front of the Rockies is appreciably lowered by the presence of frequent, strong westerly winds. Upland vegetation surrounding the fen is predominately mixed grass and foothills prairie dominated by grasses such as *Agropyron spi-*

catum, *Bouteloua gracilis*, and *Stipa comata*. Localized uplifts support open forests dominated by *Pinus flexilis*.

METHODS

I collected plant specimens and made observations during six trips to the study area from May through August 1982. Nomenclature follows Hitchcock and Cronquist (1973) for vascular plants and Crum et al. (1973) for mosses. Specimens were deposited in the herbarium at the University of Montana, Missoula (MONTU).

To characterize the vegetation, I conducted quantitative sampling during the last week in August, essentially following the techniques of Daubenmire (1959). I subjectively placed 10 transects in distinct and homogenous stands of vegetation. For each stand I laid out a 50-m baseline parallel to the slope and placed 20 plots 20×50 m at regular intervals along this line. I estimated canopy cover for each species in each plot by assigning it to one of seven classes: T=0–1%, 1=2–5%, 2=6–25%, 3=26–50%, 4=51–75%, 5=76–95%, and 6=96–100%. For each transect, average cover for each species is the mean of the 20 midpoints of the assigned cover classes. I estimated average shrub height to the nearest dm. I determined pH and conductance values of surface water from natural depressions using portable meters. I mapped vegetation using a 1:24000 infrared photograph supplemented by on-site inspection.

Prominence values (PV) were obtained using the formula $(PV=C\sqrt{F})$ where C =% canopy cover and F =absolute frequency (Beals 1960). Sorenson's Index of Similarity (S_s) was computed using the formula $S_s=2w/a+b$ where w =number of the species common to both areas, and a and b are the numbers of species in areas A and B, respectively (Mueller-Dombois and Ellenberg 1974).

RESULTS AND DISCUSSION

Surface Patterning

The Pine Butte Fen displays patterning similar to that of boreal mires and is among the southernmost patterned peatlands in North America, occurring in a region with a relatively low precipitation/evaporation ratio. The recurring pattern found throughout the Pine Butte Fen is one of parallel low ridges (strings) approximately 0.5 m high and 0.5–1.0 m wide alternating with shallow water-filled depressions (flarks) 0.5–2.0 m wide. Strings and flarks lie transverse to the slope, perpendicular to the direction of water movement (Fig. 2). Similar patterned mires have been described by Gorham (1957), Heinselman (1963, 1965), Sjors (1959, 1963), and Glaser et al. (1981).

A number of theories attempt to explain the origin of these patterns. Since strings and

flarks are generally found on a slope and are always aligned perpendicularly to it, the most plausible explanation involves gravity. Downhill slippage of peat may result in a series of ridges separated by splits in the surface that fill with water (Pearsall 1955). These rudimentary strings and flarks may then be further differentiated by the relatively higher productivity of the more aerobic string environment. The ponds located at the north end of the Pine Butte Fen, although not extremely elongate, are aligned across slope and may also be the result of downhill slippage (Erman 1976, Moore and Bellamy 1974). Sjors (1961, 1980) feels that string and flark patterns are not caused but merely oriented by the sloping condition. According to his theory, flarks are due to excessive waterlogging, and strings are caused by lateral pressure of ice during freeze-thaw cycles. The regeneration complex theory of Sernander and Von Post and modified by Kulczynski attempts to explain hummock-hollow microtopography in terms of differential growth rates of mosses, principally *Sphagnum* (Moore and Bellamy 1974). A completely satisfactory and all-encompassing explanation for string and flark patterning has yet to be worked out.

Vegetation

Results of the vegetation and water chemistry analysis are presented in Table 1. Based on differences in species composition, development of the shrub layer, and physiognomy of the habitat, the vegetation of the Pine Butte Fen may be divided into three community types (c.t.'s): open fen, dwarf-carr, and carr. The open fen c.t. is further divided into typical and *Scirpus* phases. In some areas of the fen these community types appear distinct; elsewhere they form a continuum.

Water chemistry analyses were too superficial for determining significant correlations; however, pH was consistently lower in the shrub-dominated carr and dwarf-carr c.t.'s. I was unable to detect any correlation between ionic concentration as measured by specific conductance and vegetation. In a study of Swedish mires, Sjors (1950) also found pH to be superior to conductivity as a predictor of vegetation type.

Open fen community type.—Open fen vegetation is dominated by graminoids and



Fig. 2. Aerial photograph of Pine Butte Fen. Note string-flark patterning that appears as parallel wrinkles.

TABLE 1. Species association table for 10 stands in the Pine Butte Fen. Values indicated are prominence values (see Methods). Conductivity and pH measurements were taken from samples of standing water. Stands are grouped by community type.

	Open fen			Open fen Scirpus phase			Dwarf carr			Carr
Stand number	1	4	8	2	5	9	3	7	6	10
Water (%cover)	42	31	45	38	40	54	0	0	5	45
Bare ground	0	0	8	0	0	0	0	0	0	0
Shrub height (dm)	4	4	4	4	4	9	13	18	12	18
Conductivity (umho/cm)	445	520	600	440	490	430	560	395	520	510
pH	7.0	7.1	7.2	7.2	7.1	7.1	6.7	6.8	6.6	6.9
MOSSES										
<i>Drepanocladus revolvens</i>	174	80	17	146	55	0	25	0	3	0
<i>Scorpidium scorpioides</i>	60	25	0	51	29	92	0	0	0	0
<i>Campylium stellatum</i>	178	320	145	206	204	132	158	71	207	1
<i>Rhynchostegiella compacta</i>	0	0	2	0	0	1	29	54	89	1
<i>Calliergon giganteum</i>	0	0	0	0	0	0	0	46	0	0
GRAMINOIDS										
<i>Carex livida</i>	17	9	12	5	6	15	0	0	0	0
<i>Carex linosa</i>	1	52	0	34	113	7	0	0	0	0
<i>Eleocharis pauciflora</i>	2	53	25	68	13	1	3	0	0	0
<i>Muhlenbergia glomerata</i>	25	13	1	3	5	15	0	0	1	0
<i>Carex simulata</i>	250	250	210	38	76	27	0	2	233	0
<i>Scirpus acutus</i>	0	0	0	268	268	256	0	0	0	0
<i>Carex buxbaumii</i>	0	1	0	0	21	0	0	0	1	0
<i>Carex aquatilis</i>	63	1	40	22	0	1	0	165	0	0
<i>Juncus balticus</i>	10	102	46	1	103	37	239	342	197	0
<i>Carex rostrata/aquatilis</i>	—	—	—	—	1	—	170	—	—	311
<i>Carex lasiocarpa</i>	0	0	0	0	0	0	32	17	0	0
FORBS										
<i>Menyanthes trifoliata</i>	279	29	0	136	1	0	0	0	0	0
<i>Utricularia vulgaris</i>	0	0	67	9	11	65	0	0	0	0
<i>Utricularia minor</i>	49	4	1	7	2	11	0	0	0	0
<i>Aster junciformis</i>	7	4	4	18	2	1	2	0	0	0
<i>Galium boreale</i>	42	1	0	64	27	1	23	6	15	0
<i>Triglochin maritima</i>	20	155	151	10	1	7	9	6	23	0
<i>Equisetum laevigatum</i>	0	0	0	0	0	0	1	38	1	47
<i>Equisetum arvense</i>	0	0	0	0	0	0	0	32	0	0
SHRUBS										
<i>Potentilla fruticosa</i>	65	18	21	117	14	20	118	1	22	0
<i>Betula glandulosa</i>	26	26	1	26	33	34	137	41	76	190
<i>Cornus stolonifera</i>	0	0	0	0	0	0	0	18	24	12
<i>Salix candida</i>	2	1	2	2	2	1	1	1	74	2
<i>Salix phylicifolia</i>	0	0	0	0	0	0	1	11	1	75

bryophytes. Shrubs are less than 1.0 m tall with cover values rarely exceeding 30%. This type is associated with poorly drained fibrous peat of the Dougcliff Series (USDA 1980). The surface of the peat displays string and flark patterning, with the flarks containing standing water during all or most of the growing season. In many areas the peat is so unconsolidated and water saturated that the entire surface seems to be floating and “quakes” when stepped on.

The strings are dominated by *Carex simulata*, *C. aquatilis*, *Juncus balticus*, *Muhlenbergia glomeata*, *Betula glandulosa*, and *Potentilla fruticosa*. Common forbs are *Triglochin maritima*, *Galium boreale*, *Aster junciformis*, *Viola nephrophylla*, and *Dodecatheon pulcherrimum*. The mosses, *Campylium stellatum* and *Drepanocladus revolvens*, form an almost continuous ground layer. Vegetation of the flarks is dominated by the aquatic dicots *Utricularia vulgaris*, *U. mi-*

nor, and *Menyanthes trifoliata* and the mosses *Scorpidium scorpioides* and *Drepanocladus revolvens*. *Carex simulata*, *C. livida*, and *Eleocharis pauciflora* are common graminoids.

Throughout the open fen are 1–5 ha patches of vegetation dominated by the bulrush *Scirpus acutus*. *Scirpus* is abundant on both strings and flarks, partially replacing *Carex simulata*. *Potentilla fruticosa* and *Betula glandulosa* have greater cover and often attain greater height in these patches than in typical open fen vegetation. All the dominant species of typical open fen vegetation are also associated with the *Scirpus*. Since the small patches of *Scirpus*-dominated vegetation cannot easily be mapped from aerial photographs, this vegetation is best referred to as the *Scirpus* phase of the open fen c.t.

Carr community type.—This community type is dominated by shrubs ranging in height from 1.0 to 3.0 m and attains total cover of greater than 50%. It is associated with mucky peat of the Winginaw Series (USDA 1980). The surface is often of a hummock-hollow microtopography, but distinct strings and flarks do not occur.

Standing water, as much as 0.5 m deep, is often present throughout the growing season. In the Pine Butte Fen, carr vegetation occurs along the margins and occasionally on isolated areas of higher ground.

The hummocks are dominated by *Betula glandulosa*, *Salix monticola*, *S. phyllifolia* var. *planifolia*, *S. serrissima*, and *Cornus stolonifera*. Depressions around the shrubs are dominated by the coarse sedges *Carex rostrata* and *C. aquatilis* and by *Equisetum laevigatum*. Forbs are uncommon, and mosses are present only at the base of shrubs.

Dwarf-carr community type.—Dwarf-carr vegetation is intermediate in appearance and composition to the carr and open fen c.t.'s, and, in some instances, a continuum of all three types occurs. Shrub development is noticeably greater than in the open fen but less than in the carr. Shrubs commonly attain heights of 0.5–2.0 m and cover of greater than 30%. Hummock-hollow microtopography is present, but distinct strings and flarks are generally not apparent. Standing water is present early in the growing season. The dwarf-carr c.t. is most common along the

edges of the Pine Butte Fen, but it is also found around ponds and in patches throughout the open fen c.t.

Dominant shrubs are *Betula glandulosa*, *Cornus stolonifera*, *Salix candida*, and *Potentilla fruticosa*. Important herbaceous species are *Carex aquatilis*, *C. simulata*, *C. lasiocarpa*, *Juncus balticus*, *Triglochin maritima*, *Equisetum laevigatum*, *E. arvense*, and *Galium boreale*. Shrubs and most forbs occur only on hummocks, whereas graminoids and *Equisetum* spp. occupy both hummocks and hollows. The mosses *Campylopus stellatus* and *Rhyncostegiella compacta* are abundant on hummocks beneath litter.

Narrow bands of vegetation dominated by *Carex rostrata*, *C. sartwellii*, *C. lanuginosa*, and *C. aquatilis* occur occasionally throughout the fen. These bands of coarse sedges run parallel to the slope, and surface water movement is often apparent. Heinselman (1963) refers to similar communities as water tracks. I did not sample this vegetation as it occupies an insignificant portion of the study area.

Aspen (*Populus tremuloides*) dominated vegetation occurs on islands of mineral soil along the east side of the Pine Butte Fen (Fig. 1). These communities were not considered in this study.

Vegetation patterns in the Pine Butte Fen are complex (Fig. 1). Throughout the fen, water percolates up through the underlying mineral substrate (Nimick et al. 1983). Percolation may not be uniform through space. Water appears stagnant in most flarks, but water flow is apparent in small drainages along the margins as well as around ponds and in water tracks. Different rates of water flow may be responsible for much of the vegetation patterning.

Jeglum (1974) states that the two most important environmental gradients affecting the vegetation, floristics, and productivity of peatlands are the moisture-aeration and pH-nutrient regimes (see also Sjors 1950, Gorham 1957, and Heinselman 1970). In saturated organic soils, oxygen is often a limiting factor. Even in mires fed by nutrient-enriched water, phosphorus and nitrogen may be limiting (Slack et al. 1980, Schwintzer and Tomberlin 1982). Areas with increased water flow will have access to greater amounts of oxygen and minerals. It has also been suggested that re-

ducing conditions in peat may promote the accumulation of toxic compounds around subterranean plant organs, a situation that is ameliorated by increased water flow (Moore and Bellamy 1974). Heinselman (1963) found that better tree growth in Minnesota peatlands was correlated with increased water movement, and Ingram (1967) believed that in some cases water movement alone may be responsible for the presence of more eutrophic vegetation.

The open fen community type had the greatest number of species common to bogs and fens throughout boreal North America. Plants such as *Utricularia* spp., *Menyanthes trifoliata*, *Muhlenbergia glomerata*, *Carex livida*, *C. limosa*, and *Eriophorum* spp. are adapted to the poor aeration and nutrient regimes of waterlogged soils (Sjors 1961, Heinselman 1970). Areas occupied by open fen probably have little water movement. The presence of the *Scirpus* phase may indicate somewhat greater water movement, perhaps resulting from increased subsurface upwelling. Lewis and Dowding (1926) and Slack et al. (1980) report similar *Scirpus* communities in Alberta fens occurring along drainage ways, ponds, and other areas of increased water flow.

Carr vegetation is probably associated with soils having relatively better oxygen and nutrient relations. Water movement is often visible in the carr c.t., and beaver activity, generally associated with moving water, is greatest in this vegetation. Greater movement of the water along the margin of the fen is expected in light of the low hydric conductivity of peat (Boelter and Verry 1977). The peat mass acts as a dam, and water, unable to pass over or through it quickly enough, flows around the margin. Moore and Bellamy (1974) attribute the existence of carr vegetation along the margin of a mire in England to the presence of drainage water circumscribing the main peat mass. In a study of peatlands in central Saskatchewan, Jeglum (1971) correlated cover attained by individual species with depth to water table. Water tables ranged from 80 cm below to 60 cm above the soil surface. *Betula glandulosa*, *Cornus stolonifera*, and five of seven species of *Salix* attained maximum cover values at depth to water table exceeding 20 cm, indicating a

preference for the increased aeration of the better drained soils. In the Pine Butte Fen, *Betula*, *Cornus*, and *Salix* attained maximum height and cover values in the carr c.t., probably responding to the more favorable conditions provided by greater water movement or better aerated soil. The dwarf-carr c.t., intermediate in shrub development, is probably also intermediate in its requirements for nutrients and oxygen in the rooting zone.

An alternative explanation for the distribution of vegetation in the Pine Butte Fen follows the lines of classic hydrarch succession in which the direction of change is from an aquatic to a terrestrial environment (Oosting 1948). Aquatic plants are replaced by herbaceous emergents, which are in turn replaced by woody plants that increase transpiration and lower the water table (Dansereau and Segadas Vianna 1952). Since the peripheral carr vegetation frequently has deeper surface water than the center of the mire, a simple explanation based on hydrarch succession seems untenable. Although the major vegetation patterns displayed in the Pine Butte Fen can be accounted for by a theory based on the movement of water, confirmation of this theory requires thorough analysis of water chemistry throughout the fen.

Floristics

I observed 93 species of vascular plants and nine species of mosses in the Pine Butte Fen (Appendix A). I believe the vascular plant list to be nearly complete, whereas the list of bryophytes is certainly incomplete and probably includes only the most common moss species. The majority of vascular species occurred on hummocks, often in association with shrubs. Many, such as *Fragaria virginiana*, *Galium boreale*, *Senecio pauperculus*, *Smilacina stellata*, and *Vicia americana*, although common in the fen, were at least as common in adjacent upland communities. A much smaller number of species was found in the standing water of depressions. Moore and Bellamy (1974) state that low oxygen tensions associated with waterlogged soils is one of the major problems faced by peatland vegetation. Possibly the better aeration of the hummock soils provides a habitat suitable to many species not specifically adapted to mires. Eleven species of vascular plants found in the Pine

TABLE 2. Floristic similarities between the Pine Butte Fen and other peatlands in North America. S_s = Sorenson's Index of Similarity (see Methods for explanation). Ericads = number of woody ericaceous species present.

Location and reference	S_s	Distance (km)	pH	Ericads
Slack et al. (1980) Alberta. Rich fens.	28	650	6.8–7.9	4
Jeglum (1971) Saskatchewan. Eutrophic peatlands.	27	850	6.0–7.9	4
Vitt et al. (1975) Alberta. Poor fens.	8	900	5.0	8
Baker (1972) California. Fen.	7	1350	5.2–7.0	1
Heinselman (1963) Minnesota. Patterned fens.	18	1400	5.3–6.4	3
Glaser et al. (1981) Minnesota. Rich fens.	17	1400	4.3–6.9	6
Sjors (1963) Ontario. Rich fens.	24	2000	5.8–7.1	5
Schwintzer (1978) Michigan. Fens.	10	2250	5.7–7.0	3
Vitt and Slack (1975) Michigan. Bogs and fens excluding forest.	9	2200	4.9–6.7	11
Montgomery and Fairbrothers (1963) New Jersey. Bogs.	1	3150	—	10
Drury (1956) Alaska. Bogs.	19	4000	—	8

Butte Fen are restricted to bogs and fens throughout their range (Appendix A). A major environmental factor influencing mire vegetation is the mineral concentration and coincident hydrogen ion concentration (pH) of the water (Vaughman 1980). A gradient of ombrotrophic (mineral-poor, low pH) to minerotrophic (mineral-enriched, high pH) water determines the continuum of bog to rich fen (Sjors 1950). Ombrotrophic bogs are characterized by “acid-loving” species-poor floras, whereas minerotrophic rich fens typically have a greater number of vascular species, some of which are calciphiles (Gorham 1957). Karlin and Bliss (1984) feel that the greater species diversity of strongly minerotrophic mires is a reflection of the complex interactions of microrelief and substrate chemistry gradients. The Duhr Fen displays a high species diversity common to rich fens, and many of the common mosses, such as *Scorpidium scorpioides*, *Drepanocladus revolvens*, and *Campylium stellatum*, are considered rich fen indicators (Sjors 1950, Slack et al. 1980).

Many bogs and fens throughout North America have been studied floristically. Al-

though vascular plant species lists reported for other mire systems may be incomplete, comparisons using Sorenson's Index of Similarity (S_s) indicate degree of relationship and point to factors controlling floristic differences (Table 2). In general, floristic similarity to the Pine Butte Fen decreases with decreasing pH and increasing distance of separation. All other mire systems reported in the literature that I surveyed have at least one species of ericaceous shrub, and, in those cases where bryophytes were also included, all have at least one species of *Sphagnum*. Rich fens in Alberta and Saskatchewan show the greatest similarity to the Pine Butte Fen; however, none of the bogs and fens surveyed have a similarity to the Pine Butte Fen greater than 30%. In contrast, Wheeler et al. (1982) found much greater similarity between their study area in northern Minnesota and peatlands in Ontario, Saskatchewan, and Michigan ($S_s > 40\%$).

A major factor responsible for the floristic uniqueness of the Pine Butte Fen is climate. Bogs and fens generally occur in regions with a cool, moist climate (Dansereau and Segadas-

Vianna 1952, Sjors 1961). Walther and Leith (1960) have prepared world climatic zone maps based, in part, on length of growing season and precipitation/evaporation ratios. These maps place the Pine Butte Fen in the arid continental zone, whereas all other patterned fens of significant size reported in the literature for North America occur in more mesic zones (e.g., typical temperate, warm temperate, boreal, and arctic). The aridity of the Pine Butte area may account for the distinctness of its peatland flora in two ways. First, *Sphagnum* spp. are important components of most northern mire vegetation, and, although *Sphagnum* can establish in calcareous regions (Gorham 1957, Heinselman 1963), it grows only in moist areas (Moss 1953). The absence of *Sphagnum* and the localized acidity associated with it may be responsible for the absence of ericaceous shrubs, *Drosera* spp., and other "acid-loving" species from the Pine Butte Fen. Secondly, a large number of species found in the Pine Butte Fen are derived from adjacent upland communities and are adapted to the regional aridity. Many of these species are not available to mire systems occurring in different climatic regions. The presence of nutrient-enriched groundwater, the microtopographic heterogeneity due to the various surface patterns, the large size of the mire, and the relatively xeric climate of the region are undoubtedly all factors contributing to the large and unique flora of the Pine Butte Fen.

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APPENDIX A

List of vascular plants and bryophytes of the Pine Butte Fen. The * indicates species that are restricted to bogs and fens throughout their range.

APIACEAE

Cicuta douglasii (DC.)
Coul. & Rose

ASTERACEAE

Antennaria pulcherrima (Hook.) Greene
Antennaria microphylla Rydb.
Aster junciformis Rydb.
Aster occidentalis (Nutt.)
Torr. & Gray
Crepis runcinata (James)
Torr. & Gray ssp.
hispidulosa (Howell)
Babc. & Stebb.
Helianthus nuttallii
Torr. & Gray
Senecio pauperculus Michx.
Solidago canadensis L. var.
salebrosa (Piper) Jones
Solidago nemoralis Ait. var.
longipetiolata (Mack. &
Bush) Palmer & Steyerma.
Taraxacum laevigatum
(Willd.) DC.
Taraxacum officinale Weber

BETULACEAE

**Betula glandulosa* Michx.
var. *glandulosa*

CAMPANULACEAE

Campanula rotundifolia L.
Lobelia kalmii L.

CORNACEAE

Cornus stolonifera Michx.
var. *stolonifera*

CYPERACEAE

Carex atherodes Spreng.
Carex aquatilis Wahl.
Carex aurea Nutt.
Carex bixbaumi Wahl.
Carex capillaris L.
Carex diandra Schrank
Carex dioica L. var.
gynocrates (Wormsk.)
Ostenf.
Carex disperma Dewey
Carex interior Bailey
Carex lanuginosa Michx.
Carex lasiocarpa Ehrh. var.
americana Fern.
**Carex linosa* L.
**Carex livida* (Wahl.) Willd.
Carex nebrascensis Dewey
Carex oederi Retz. var.
viridula (Michx.) Kuek.
Carex rostrata Stokes
Carex sartwellii Dewey
Carex scirpoidea Michx. var.
scirpoidea
Carex simulata Mack.
Eleocharis palustris (L.)
R. & S.
Eleocharis pauciflora
(Lightf.) Link
**Eriophorum polystachion* L.
**Eriophorum viridicarinatum*
(Engelm.) Fern.
Scirpus acutus Muhl.

EQUISETACEAE

- Equisetum laevigatum* A. Br.
Equisetum variegatum
 Schleich.

ERICACEAE

- Pyrola asarifolia* Michx.
 var. *asarifolia*

FABACEAE

- Vicia americana* Muhl. var.
truncata (Nutt.) Brew.

GENTIANACEAE

- Gentiana amarella* L.
Gentiana dentosa Rottb.

IRIDACEAE

- Iris missouriensis* Nutt.

JUNCACEAE

- Juncus alpinus* Vill.
Juncus balticus Willd. var.
montanus Engelm.

JUNCAGINACEAE

- Triglochin maritimum* L.
Triglochin palustre L.

LENTIBULARIACEAE

- **Utricularia minor* L.
Utricularia vulgaris L.

LILIACEAE

- Allium schoenoprasum* L.
Lilium philadelphicum L.
Smilacina stellata (L.)
 Desf.

MENYANTHACEAE

- **Menyanthes trifoliata* L.

ONAGRACEAE

- Epilobium palustre* L.

ORCHIDACEAE

- Corallorhiza trifida* Chat.
Cypripedium calceolus L.
 var. *parviflorum*
 (Salisb.) Fern.
Habenaria hyperborea (L.)
 R. Br.
Spiranthes romanzoffiana
 Cham. var. *romanzoffiana*

POACEAE

- Agropyron caninum* (L.)
 Beauv. var. *unilaterale*
 (Vasey) Hitchc.
Agrostis alba L. var. *alba*
Bromus ciliatus L.
Calamagrostis inexpansa Gray
 var. *inexpansa*
Deschampsia cespitosa (L.)
 Beauv. var. *cespitosa*
 **Muhlenbergia glomerata*
 (Willd.) Trin.
Muhlenbergia richardsonis
 (Trin.) Rydb.

POLEMONIACEAE

- Phlox kelseyi* Britt. var.
kelseyi

PRIMULACEAE

- Dodecatheon pulchellum*
 (Raf.) Merrill var.
pulchellum
Lysimachia thrysiflora L.

RANUNCULACEAE

- Anemone parviflora* Michx.
Thalictrum venulosum Trel.

ROSACEAE

- Fragaria virginiana*
 Duchesne var. *glauca*
 Wats.
Potentilla fruticosa L.
Potentilla gracilis Dougl.
 var. *elmeri* (Rydb.) Jeps.

RUBIACEAE

- Galium boreale* L.

SALICACEAE

- Salix bebbiana* Sarg. var.
perrostrata (Rydb.)
 Schneid.
 **Salix candida* Fluegge
Salix drummondiana Barratt
Salix monticola Bebb.
Salix myrtifolia Anderss.
Salix phylicifolia L. var.
planifolia (Pursh) Hiit.
Salix rigida Muhl. var.
watsonii (Bebb.) Cronq.
 **Salix serrissima* (Bailey)
 Fern.

SAXIFRAGACEAE

- Parnassia palustris* L.
 Scrophulariaceae
Castilleja miniata Dougl.
 var. *miniata*
Castilleja sulphurea Rydb.
Pedicularis groenlandica
 Retz.

VALERIANACEAE

- Valeriana edulis* Nutt. var.
edulis

VIOLACEAE

- Viola adunca* Sm. var. *adunca*
Viola nephrophylla Greene
 var. *cognata* (Greene)
 Hitchc.

MOSSES

- Bryum pallescens* Schleich.
Calliergon giganteum
 (Schimp.) Kindb.
Campylopus stellatus (Hedw.)
 C. Jens.
Drepanocladus exannulatus
 (S. S. G.) Warnst.
Drepanocladus revolvens
 (Sw.) Warnst.
Mnium rugicum Laur.
Platydictya jungernanioides
 (Brid.) Crum
Rychostegiella compacta
 (C. Muell.) Loeske
Scorpidium scorpioides
 (Hedw.) Limpr.

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